CRREL'S FIRST 25 YEARS

1961–1986

PREFACE

This commemorative booklet incorporates much of the material and personal reflections that have been assembled over the years for use in preparing the history of CRREL.

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CRREL CHRONOLOGY

1944 – Frost Effects Laboratory established in Boston, Massachusetts, within the New England Division, Corps of Engineers, to coordinate research on the effects of frost on the design and construction of roads, airfields and structures in frost-affected areas.

1945 – The Permafrost Division of the St. Paul (Minnesota) District, Corps of Engineers, established to determine design methods and construction procedures to be used in the construction of airfields on permanently frozen ground.

1949 – SIPRE (the Snow, Ice and Permafrost Research Establishment) established within Corps to conduct basic and applied research in snow, ice and frozen ground.

1951 – SIPRE moves to Wilmette, Illinois.

1953 – ACFEL established in Boston by combining Frost Effects Laboratory and Permafrost Division of the St. Paul District.

1959 – Camp Century in Greenland is first occupied.

1961 – CRREL established (on 1 Feb 1961) in Hanover, New Hampshire, by combining SIPRE and ACFEL, Colonel William Nungesser is appointed Commanding Officer.

1962 – Fire causes extensive damage to main laboratory building at CRREL during construction. CRREL transferred from Corps of Engineers to the Army Materiel Command. W. Keith Boyd becomes first Technical Director.

1963 – Laboratory fully operational; first open house, 22–24 November.

1964 – Colonel Philip Krueger succeeds Colonel Nungesser.

1966 – Colonel Dmitri Kellogg succeeds Colonel Krueger.

1967 – Colonel John Wagner succeeds Colonel Kellogg.

1968 – CRREL redesignated U.S. Army Terrestrial Sciences Center (TSC). CRREL drillers accomplish first penetration of Greenland ice sheet. Facilities Engineering Building completed.

1969 – "TSC" reassigned to Corps of Engineers and CRREL designation is reassigned. CRREL drillers make first penetration of Antarctic ice sheet.

– First voyage of *Manhattan.*

1970 – Lieutenant Colonel Joseph Castro succeeds Colonel Wagner. Second *Manhattan* voyage. Photographic Interpretation Research Division transferred to the Army Materiel Command.

1972 – Dr. Dean Freitag becomes Technical Director. Large anti-Vietnam War demonstrations staged at CRREL.

1973 – Colonel Robert Crosby succeeds Colonel Castro.

1974 – Alaskan Division reorganized as Alaskan Projects Office.

1976 – Logistics and Supply Building completed.

1977 – CRREL addition completed.

1978 – CRREL receives Army Special Award for Accomplishment; Ice Engineering Facility officially opened; Colonel Alfred Devereaux succeeds Colonel Crosby.

1979 – CRREL receives U.S. Army Award for Excellence. Ice Engineering Facility dedicated.

1981 – CRREL's 20th Birthday Celebration on 16 September. Colonel Wayne Hanson succeeds Colonel Devereaux.

1982 – Dr. Lloyd Breslau becomes Technical Director.

1983 – Colonel Morton Roth succeeds Colonel Hanson.

1985 – Frost Effects Research Facility completed and dedicated.

1986 – Dr. L.E. Link becomes Technical Director.

INTRODUCTION

On the 15th of June 1960, a small group of individuals assembled on a tract of land about 11/2 miles north of Dartmouth College in Hanover, New Hampshire, to lay the cornerstone for a new research laboratory. Among them were Brigadier General Duncan Hallock, Chief, Research and Development Division, of the U.S. Army Corps of Engineers, Brigadier General Alden Sibley, Division Engineer of the New England Division, U.S. Army Corps of Engineers, Dr. John Sloan Dickey, President of Dartmouth College, Wesley Powell, Governor of New Hampshire, Kenneth A. Linell, Director of the Arctic Construction and Frost Effects Laboratory, and Colonel William Nungesser, Commanding Officer of the Snow, Ice and Permafrost Research Establishment.

These individuals had assembled to mark the beginning of construction of the Cold Regions Research and Engineering Laboratory, or CRREL, as it soon was to be known. And each of them represented the many forces that had come together to bring CRREL into existence.

Brigadier General Duncan Hallock represented the U.S. Army Corps of Engineers, which was, of course, the organization most directly involved in establishing CRREL. The Corps had been responsible for establishing and maintaining the two predecessor organizations that made up CRREL:

Cornerstone laying ceremonies. L to R: Brig. Gen. Duncan Hallock, Chief, Research and Development Division, Office of the Chief of Engineers, Washington, D.C.; Gov. Wesley Powell, State of New Hampshire; Brig. Gen. Alden K. Sibley, Division Engineer, New England Division, U.S. Army Corps of Engineers; and Dr. John Sloan Dickey, President, Dartmouth College.

Cornerstone laying ceremonies. L to R: Col. William L. Nungesser, Brig. Gen. Duncan Hallock and Brig Gen. Alden K. Sibley.

the Snow, Ice and Permafrost Research Establishment (SIPRE) and the Arctic Construction and Frost Effects Laboratory (ACFEL). Especially through the efforts of Robert Philippe, of the Engineering Research and Development Division, the Corps of Engineers had been planning the establishment of a consolidated cold regions laboratory for more than a decade.

Brigadier General Alden Silby represented the Corps of Engineers' New England Division, which had been involved in cold regions research and in the establishment of ACFEL, and which would play a major role in constructing CRREL.

The President of Dartmouth College, Dr. John Sloan Dickey, had been instrumental in bringing the new lab to the Hanover area. Dartmouth had leased the land for CRREL to the Corps of Engineers and had the vision of the cooperative programs that now exist between Dartmouth and CRREL.

Governor Wesley Powell represented the effort by the State of New Hampshire to have the laboratory sited in Hanover. In particular, New Hampshire's U.S. Senate delegation, Senators Styles Bridges and Norris Cotton, had been instrumental in bringing CRREL to its present site.

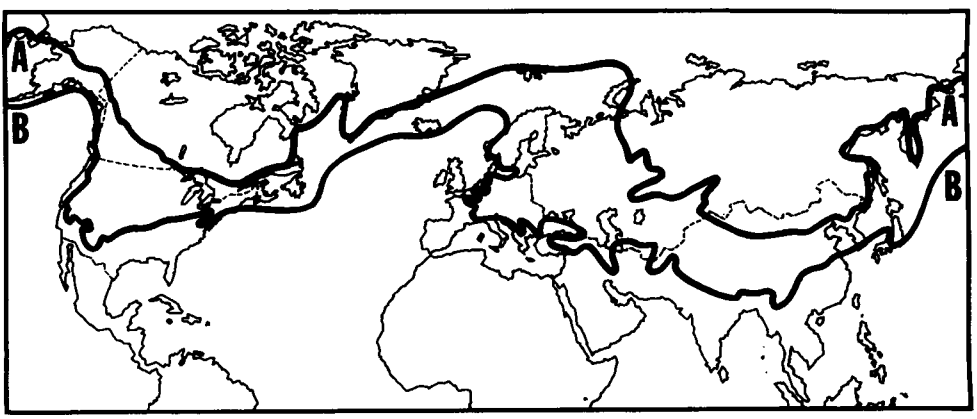
Colonel William Nungesser, Commanding Officer of SIPRE, represented the first Corps laboratory established to conduct research in the cold regions. SIPRE's role had involved both basic research and engineering, particularly in Greenland and Antarctica.

Kenneth Linell, the Director of ACFEL, was the head of the second of the two Corps of Engineers laboratories to be established for cold regions research. This laboratory, originally in Boston, and later in Waltham, Massachusetts, had pioneered much of the engineering work on frost action, permafrost, snow and ice in Alaska and on the Greenland Ice Cap.

All of these organizations and individuals assembled at this site to found a new laboratory that was to grow both in size and scientific reputation far beyond original projections. Soon after the groundbreaking ceremonies, even the name was changed to reflect the laboratory's enlarged role—from the Cold Regions Engineering Laboratory (CREL) to the Cold Regions Research and Engineering Laboratory. For the new laboratory was soon to gain a world-wide reputation not only for solving the problems of cold regions but also for investigating the basic characteristics of the cold regions environment.

Since 1963, when the main laboratory building was completed, the total space of the CRREL buildings has more than doubled, the annual budget for research has increased by an order of magnitude and the total staff has increased in number by more than 50%. And in both research capabilities and in reputation the increases have been enormous.

In the following pages is presented the story of the Cold Regions Research and Engineering Laboratory, from its predecessor organizations to its status today. Of necessity, much has been left unmentioned, but many of the major events in CRREL's history are briefly presented here. (A more complete account of CRREL's history is presented in Internal Report 917).



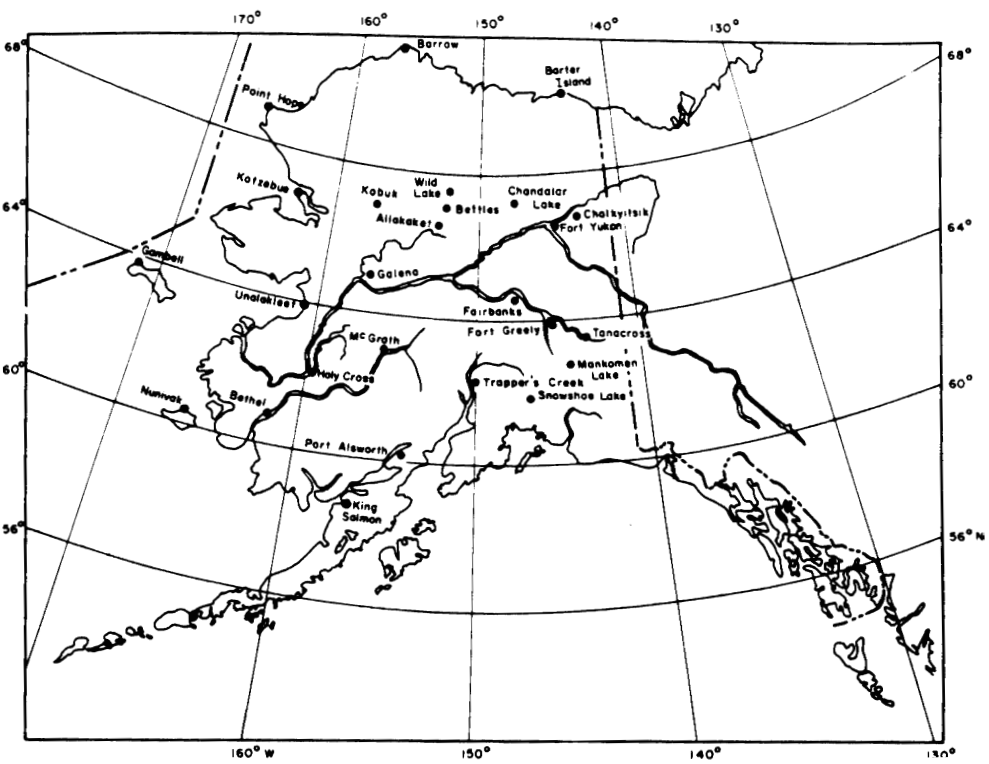
CRREL's mission in the cold regions of the Northern Hemisphere lies north of line B. (North of line A the approximate average temperature in the coldest month is 0°F; line A is also the approximate southern limit of discontinuous permafrost. North of line B the approximate average temperature in the coldest month is 32°F.)

ANTECEDENTS

In investigating the antecedents of CRREL, one must trace back through the early years of the cold regions construction activities of the Corps of Engineers, which has been involved in the exploration and development of Alaska since soon after its purchase from Russia in 1867. Explorers from the Corps surveyed the region, built the early trails that eventually became Alaska's major highways and established port facilities along much of Alaska's 5500 miles of coastline. It was not until World War II, however, that Corps construction activities in the cold regions expanded to major proportions.

Prior to U.S. involvement in World War II, the War Department recognized the strategic importance of Alaska and by early 1940 had developed a comprehensive plan for the development of a military establishment in Alaska. In 1941 the Department placed all military construction in Alaska under the control of the Corps of Engineers. In the next 2 years the Corps completed Ladd Field in Fairbanks, built Fort Richardson at Anchorage, and constructed airfields on the Aleutian Islands and posts at Kodiak, Dutch Harbor and Sitka.

Yet the most extraordinary project performed by the Corps in Alaska during this period was the construction of a road that established an all-land link between Alaska, Canada and the continental United States for the first



Alaska.

time. Soon after Pearl Harbor (in January 1942), President Roosevelt requested that the War and Interior Departments begin to study and make recommendations for an Alaskan military road to protect the territory from the Japanese. By March, plans had been drawn up for 1450-mile-long road from the railhead at Dawson Creek, Alberta, Canada, to Fairbanks, beginning perhaps the largest construction project undertaken by the Corps since the Panama Canal.

Over 10,000 workers, both military and civilian, completed this "Pioneer Road" through 1450 miles of wilderness in only 8 months. Personnel working on the road had to deal with extremely difficult conditions, involving tundra, permafrost, muskeg, and numerous streams and rivers. This road, later called the Alcan Highway, has since been greatly improved and now serves as an important route to Alaska.

On 7 and 8 June 1942, the completion of "The Burma Road of the North," as the Pioneer Road was then called, was given an additional impetus when the Japanese invaded and occupied Attu and Kiska Islands, far out on the Aleutian chain. This event also spurred efforts to develop landing strips to complement the Canadian airfields then under construction that stretched along the highway from Edmonton to Whitehorse. These, combined with six fields in Alaska (Northway, Tanacross, Big Delta, Ladd, Galena and Nome) constituted the U.S. air link with Alaska and the USSR, called the Northwest Staging Route. Although a principal role of the highway was to make possible the building and supplying of these airfields, pilots soon discovered that the road served an important function as a visual guide for these flights.

At the same time that the Alcan Highway was being built, the Corps was also constructing four connecting pipelines in Canada and Alaska totaling 1600 miles—twice the distance of the present trans-Alaska pipeline from Prudhoe Bay to Valdez. CANOL, as it was called, was to be a fuel supply backup for trucks on the Alcan Highway and planes using the Northwest Staging Route. In its first and only year of operation, 1,102,000 barrels of crude passed through from Norman Wells to Whitehorse.

The Permafrost Division and Alaska Field Station

The Permafrost Division was founded by the St. Paul District of the Corps following a Conference on Permafrost, held at St. Paul, Minnesota, in January 1945. The Office of the Chief of Engineers (OCE) had initiated the conference because of the problems that the Army Air Forces were experiencing with the airfields along the Alcan Highway and in Alaska.

The conferees concluded that a field station should be established in Alaska to coordinate the laboratory and research work performed there. The proposed base for this laboratory was Ladd Field (now Fort Wainwright, near Fairbanks) but securing space and proper facilities there was not possible at that time. The Permafrost Division chose Northway Airfield as their temporary field station in February 1945.

From that time on, most of the activities of the Permafrost Division of the St. Paul District were based in Alaska. The Alaskan unit consisted of four officers, 1 enlisted man, 6 engineers, 19 “staff” and 13 laborers. The engineers began testing at Northway on 26 February 1945. In addition to observing and cataloging the stress factors on the structures and runways, they also constructed an experimental test area to obtain data on permafrost behavior. They found that thawing of the subsoil under the hanger at Northway had reached 25 ft after only 3 years and that the most stable structures were ones that were supported on sand and gravel fills and on piles embedded in the permafrost.

By September of 1945, the entire Field Operations Branch moved, with personnel and equipment, to Ladd Field, although they maintained their ongoing research at Northway until 1948. Many studies were conducted on facilities, such as barracks, the hospital and power plants. However, a field site with permanently frozen soils, typical of interior Alaska, was considered more desirable for detailed research. Accordingly, 135 acres of undisturbed ground on the Farmer’s Loop Road, about 3 miles northeast of Fairbanks, was leased. While the experimental area has had several names over the years, its most common name was the Alaska Field Station.

Active construction of test facilities began in 1946 with the building of a weather station, the installation of ground temperature sensors and the establishment of test sections. Additional buildings with experimental foundations were also constructed in the mid-1950s and 1960s, including pile foundations, concrete rafts and ducted foundations. While these buildings provided office, laboratory, garage, storage and living quarters for the station, their instrumented foundations also provided valuable information on the long-term performance of each system on the relatively warm permafrost of this area.

Alaska Field Station.

Experimental foundations at Alaska Field Station.

Testing and research at the Alaska Field Station has continued to provide information on construction practices in the Far North now for nearly four decades.

Frost Effects Laboratory and ACFEL

In the early 1940s, a special soils laboratory was established on Commonwealth Avenue for the Boston District of the New England Division, Corps of Engineers. This laboratory pioneered soil testing experiments aimed at minimizing frost damage to runways. Soon OCE began to refer many of the early runway problems to this small laboratory of about a dozen engineers and draftsmen.

For about three years the laboratory operated as a department within the Soils Lab of the Boston District, but the demands from Washington for its specialized services increased and the Frost Effects Laboratory was established as a separate entity. There was also an increased demand for the services of the Frost Effects Laboratory from airfields in the northern continental United States (excluding Alaska, which fell under the newly established Permafrost Division's jurisdiction). The laboratory published its first Frost Effects Technical Manual in 1946; it was called "Pavement Design for Frost Conditions" (TM 5–818–2) and, having been constantly updated, is still in use by design engineers today. This manual was accompanied by a number of other Engineering Manuals on the design of roads and airfields subject to frost conditions.

In 1947, a research effort was begun on the Greenland Ice Cap. In the areas explored, Frost Effects Laboratory researchers found enormous areas of hard ice that could support very heavy supply aircraft on wheels. The researchers also found that weather conditions on the Ice Cap were no more

Examining an ice core obtained with a CRREL auger.

severe than at some existing military land stations in northern North America.

After the early Greenland studies, the Frost Effects Laboratory received a number of assignments concerning the properties of snow, ice and seasonally frozen ground—whenever these natural phenomena affected the construction of buildings, roads, airstrips and foundations. Researchers from the lab soon constructed two coldrooms for their laboratory experiments.

In 1948 the laboratory went to work for the Hydrographic Office of the U.S. Navy, with, of course, authorization from OCE. The purpose of the project was to develop a portable ice mechanics test kit for boring holes in ice, obtaining ice cores and measuring the physical properties of ice in the field. The resulting Ice Mechanics Test Kit was soon used not only by the Navy, but also by the Woods Hole Oceanographic Institution, which had been carrying on some experiments with sea ice at Point Barrow, Alaska, in 1949. The kit contained the forerunner of a 3-in. CRREL ice auger, which has become a standard instrument for glaciology studies.

Both the Frost Effects Laboratory and the Permafrost Division of the St. Paul District had active roles to play in the construction of the airfield at Thule, Greenland, formerly a weather station and soon to become, in 1952, the northernmost Air Force Base. Such cooperation between the Frost Effects Laboratory and the Permafrost Division of St. Paul was on the increase when the two research organizations were merged. The merger seemed appropriate as the two organizations had been working together since 1950 and most personnel knew each other on a first-name basis. The merger became official on 25 February 1953 by OCE General Order No. 3

Project AT-43, Thule, Greenland. General view of Solo Expedition camp site after a snowstorm.

establishing the Arctic Construction and Frost Effects Laboratory (ACFEL). Two of the engineers from St. Paul moved to Boston to become part of the new organization. With the merger, ACFEL inherited the Alaska Field Station, at Fairbanks.

ACFEL conducted many studies during the early 1950's—most of which had a direct bearing on the subject of airfields. One study worthy of mention was entitled *Depth of Snow Cover in the Northern Hemisphere*. This study presented the average snow depths between 31 October and 31 May around the Earth's entire northern hemisphere, and cited thousands of stations as its reference points, with maps illustrating areas of varying snow depths.

In the spring of 1953, ACFEL was again called to Greenland because of the subsidence of some runway pavement sections during the previous summer. The ACFEL investigators found high ice-content soils in the test pits. They predicted further subsidence of 2 to $2^1/_2$ ft and recommended that the runways be dug up and relaid to ACFEL specifications, which they were.

In 1954, Camp TUTO was begun, in the lake area of the Ice Cap, 14 miles southeast of Thule, to serve as a rendezvous and research base for scientific exploration of the Ice Cap. But getting to the site from Thule with supplies and heavy construction equipment presented a difficult problem. Roads had to be built through the bouldery permafrost terrain and over the glacial ice. ACFEL engineers found it not only feasible to construct and maintain military gravel roads on the Greenland Ice Cap,

Height of fill on ramp road, August 1955.

Start of first 1958 swing.

Aerial view of Camp TUTO, the advance base of the 1st Engineer Arctic Task Force. In the background is the beginning of the Greenland Ice Cap, July 1956.

but also concluded that their findings would apply to the construction of airstrips in other ice locations with sufficiently level terrain.

In 1956, Boston University, involved in expanding its campus, bought the building on Commonwealth Avenue in which ACFEL had leased its quarters. In March of that year, ACFEL needed to move. The New England Division of the Corps had arranged for temporary quarters at the Murphy Army Hospital in Waltham, Massachusetts, but had not arranged for a paralyzing blizzard that struck the city the very same day that ACFEL was forced to move. It seemed somehow appropriate that the Arctic Construction and Frost Effects Laboratory, after having endured the rigors of Alaska and Greenland, should suddenly become snowbound while moving several miles from Boston to Waltham. Most of their trucks got stuck in the snow, but the personnel of ACFEL had been told to complete the move within 24 hours, and complete it they did.

Unfortunately, ACFEL's relocation to the Murphy Army Hospital was far from satisfactory There was a shortage of space, a lack of adequate facilities and "various other operational difficulties." These deficiencies resulted in the curtailment of several important ongoing investigations. But soon ACFEL's research programs were again in force, including studies of pile performance in permafrost, frost penetration in soils, closure phenomena in ice tunnels and development of new ground temperature monitoring equipment for frozen soils. By 1960, ACFEL occupied 29,380 ft^2 of working space in three buildings at the hospital, which by then had

been converted primarily into the headquarters of the New England Division of the Corps, and had a staff of 33 employees. Furthermore, the testing laboratory was equipped with more than 250 pieces of testing equipment, and it had three walk-in coldrooms by that time as well.

SIPRE

On 27 August 1947, R.L. Tolbert of the Engineer Research and Development Division, of the Office of the Chief of Engineers, wrote a proposal to Colonel Dean, then commanding the Division. It was entitled, "Snow Mechanics Laboratory."

This was the beginning of SIPRE, the Snow, Ice and Permafrost Research Establishment. This proposal initiated a conference, called by the Engineer Research and Development Division, OCE, and held on 25 September 1947. The purpose of the conference was "to ascertain the feasibility and desirability of establishing a Snow and Ice Mechanics Laboratory, on a Department of National Defense basis, for service to all Branches of the Army, Navy, Air Force and other Government Agencies."

As originally proposed, the funding for the establishment of SIPRE was estimated at $90,000 for fiscal year 1949 and $198,000 for fiscal year 1950 and these costs would be split equally among the three services. On 3 March 1949, SIPRE was given a temporary home at the U.S. Army Map Service's Headquarters in Washington, D.C. Although the official order establishing the lab had yet to be made, the Map Service was given comprehensive background information on the organization, function and administration of SIPRE. One engineer would be designated as Temporary Director of the Establishment and two others as his assistants. Two clerical workers would handle the secretarial and typing chores and the services of three or more consultants would be obtained. On 3 March 1949, General Order No. 2 officially established SIPRE.

SIPRE's move from temporary quarters in Washington—where the Establishment was little more than an organization on paper—to more permanent quarters in the St. Paul District came soon afterward. OCE's implementing memo was explicit about the operation and function of SIPRE; and it authorized the St. Paul District to recruit SIPRE's staff and to contract with private institutions "to analyze the requirements for an orderly program for research in snow, ice and permafrost."

For those first 2 years of its life, SIPRE had no lab it could call its own. Nevertheless, the scientists of SIPRE did make use of the facilities of the Central Sierra Snow Laboratory for the collection of micrometeorological and other data pertinent to snow and ice research. The Central Sierra Snow Laboratory was one of four labs that participated in what was called the Cooperative Snow Investigations, founded in 1945, and under the overall jurisdiction of the South Pacific Division, Corps of Engineers.

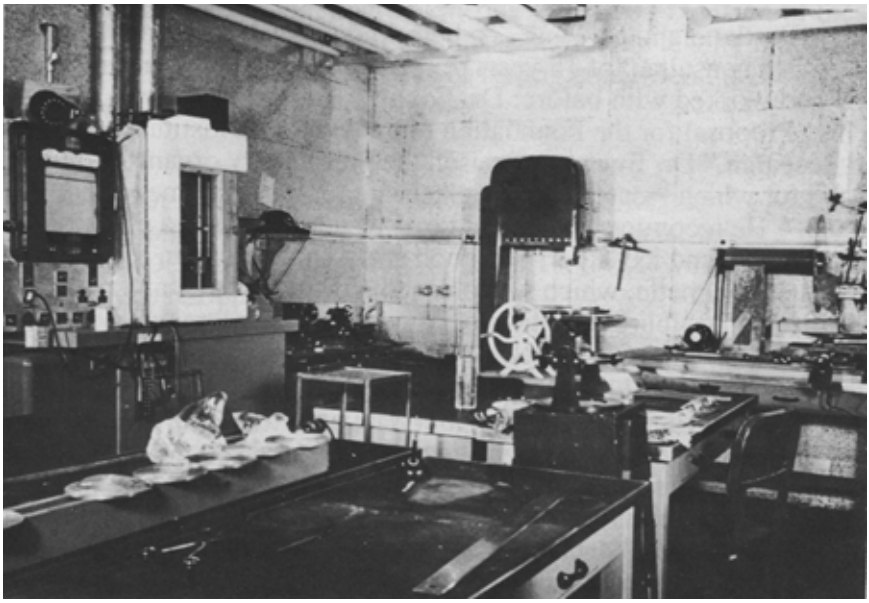
This situation was changed by the outbreak of the Korean Conflict in June of 1950. OCE requested that the St. Paul District find a new, more

functional home for SIPRE and by 23 October, Henry Manger (SIPRE's Chief) wrote that cities then being considered as possible "permanent" locations for SIPRE included Boston, Cincinnati, Dayton, Denver, Fairbanks, Portland and St. Paul. To help find a suitable location, SIPRE called in a consultant of 15 years' experience in snow and ice research, one they had worked with before: Dr. Edwin E. Bucher of Davos, Switzerland. In his "Proposal for the Foundation of an American Institute for Snow and Ice Research," Dr. Bucher appraised the preliminary organization of SIPRE as one for which "reasonable progress in a reasonable time cannot be expected." He recommended a change of location close to a university equipped for snow and ice experimentation and—separate from the report— suggested Wilmette, which was close to Northwestern University in Evanston, Illinois, a suburb of Chicago.

The new home for SIPRE was a three-story, 10-year-old building with a total floor area of 11,000 ft^2 and a parking lot for eight cars at 1215 Washington Avenue, Wilmette, Illinois, about a mile north of Northwestern University. Of the nine properties investigated in the area from 9 to 11 April, this building, then housing the "Shore Line Cleaners," seemed to be the best.

The official moving date had been set for 1 July, and what the SIPRE staff found at 1215 Washington Avenue in Wilmette was the remains of a cleaning establishment that had not been cleaned out. Their sign still proclaimed them as the "Shore Line Cleaners" and, until it was removed, they were said to have been approached with the neighborhood's dirty linen.

Building occupied by SIPRE.

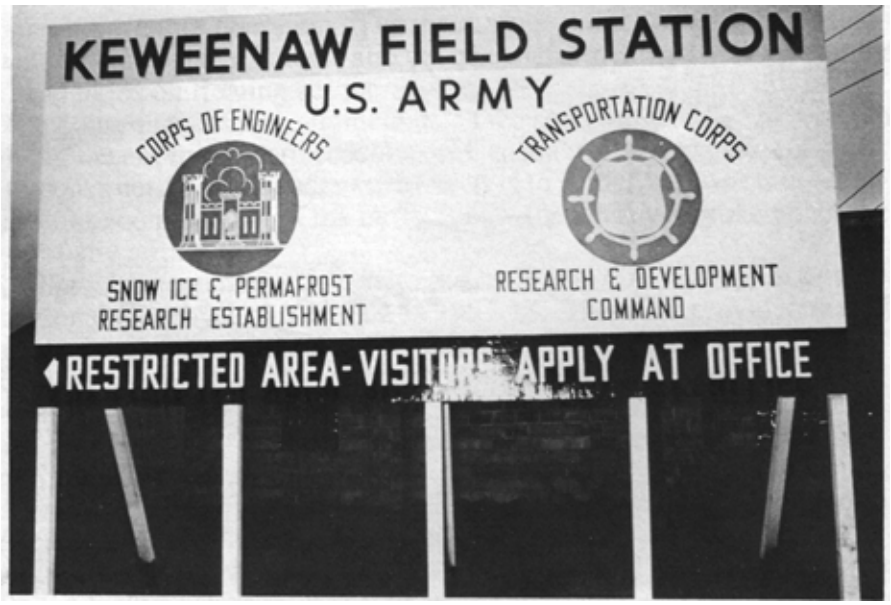


SIPRE coldroom.

Although SIPRE finally had its laboratory at Wilmette, with six coldrooms in which the temperature could be controlled to –58°F, its personnel roster was still far from complete. Specialists in the fields of snow, ice and permafrost were extremely hard to find. In all, 17 people moved to Wilmette from St. Paul.

In June of 1951 Lieutenant Colonel Lahlum was appointed Commander of SIPRE. When his tour of duty ended in the fall of 1952, he advised OCE not to replace him with a military commander but to appoint a civilian, instead. As a result, OCE decided to appoint Dr. A. Lincoln Washburn as SIPRE's Director and, under his guidance, the staff soon grew from 17 to 30. When Dr. Washburn's father died a year later, however, "Linc," as he had become known, resigned his post in order to administer his father's estate. But he did maintain ties with the Laboratory as a consultant on glacial geology. In 1953, James Gillis was appointed Acting Director of SIPRE, and one year later, OCE decided to firm up his title to "Administrator." Dr. Henri Bader, another Swiss scientist who had been Assistant Director of the Bureau of Minerals Research, Rutgers University, was Chief Scientist during these years and Henry J. Manger was Executive Officer.

That summer of 1953 marked the beginning of construction on SIPRE's Keweenaw Field Station (William Parrott, Chief), located near the Houghton County Airport on Michigan's Upper Peninsula. During their first winter of 1953–54, SIPRE invited the Army Transportation Research and Engineering Command to Keweenaw to test a number of standard and experimental vehicles in the Michigan snow. In 1956 this organization

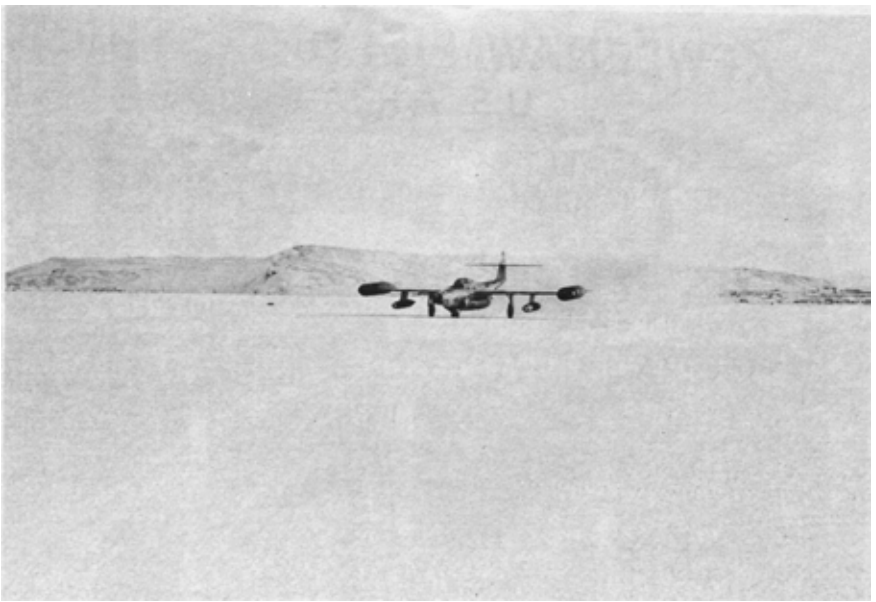


Sign at Keweenaw Field Station.

approximately 4000 ft^2 of shop space and another 4000 ft^2 of office and utility space for their own use.

Through the years that followed, many government agencies and private industries working on government contracts came to the Keweenaw Field Station. In 1957 the Signal Corps Meteorological Team, from the U.S. Army Electronic Proving Ground, selected Keweenaw as the area to evaluate instrumentation to support the Army research and development programs in the Arctic. This organization, too, enlarged the facility to accommodate its operations during the winter months and maintained a permanent complement of seven. During its tenure as SIPRE's Field Station, Keweenaw served as a test site for elements from the Ordnance Tank Automotive Command, Detroit Arsenal, Land Locomotion Laboratories, Quartermaster Laboratories, General Motors Proving Grounds, Aberdeen Proving Grounds, Waterways Experiment Station and Engineer Research and Development Laboratories. SIPRE's permanent staff of 20 employees maintained approximately 100 vehicles at Keweenaw, including tractors, snow plows, and various sizes of trucks and trailers, not to mention experimental models of vehicles undergoing arctic tests.

Meanwhile, the main SIPRE research staff was also increasing and in 1956 it was decided to convert the entire laundry building into a laboratory. Some administrative functions were moved two blocks down the street into the upper floors of an Odd Fellows Hall, which also housed a pool hall and restaurant. Also, the Purdue University photographic interpretation group, which was to form the nucleus of the Photographic Interpretation Research Division, joined SIPRE and was housed in the base-



Thule, Greenland; F-89 taxiing down sea ice runway, March 1957.

ment of the Wilmette Post Office. Then, in the summer of 1957, additional quarters were found in Evanston—in a fairly new building only four blocks from Northwestern University. However, this building also housed a laundry, which inevitably prompted jokes about SIPRE "being taken to the cleaners again." At that time the professional staff alone at SIPRE numbered 54 persons.

SIPRE's experiments with snow compaction for runways in Greenland began in the mid-1950s. SIPRE's three International Snow Compaction Conferences, held in December 1950, May 1951 and September 1952, soon secured a world-wide reputation in the field of snow compaction. As a result of these studies, increasingly heavier wheeled aircraft began to land on snow compacted runways in Greenland, Canada and Alaska.

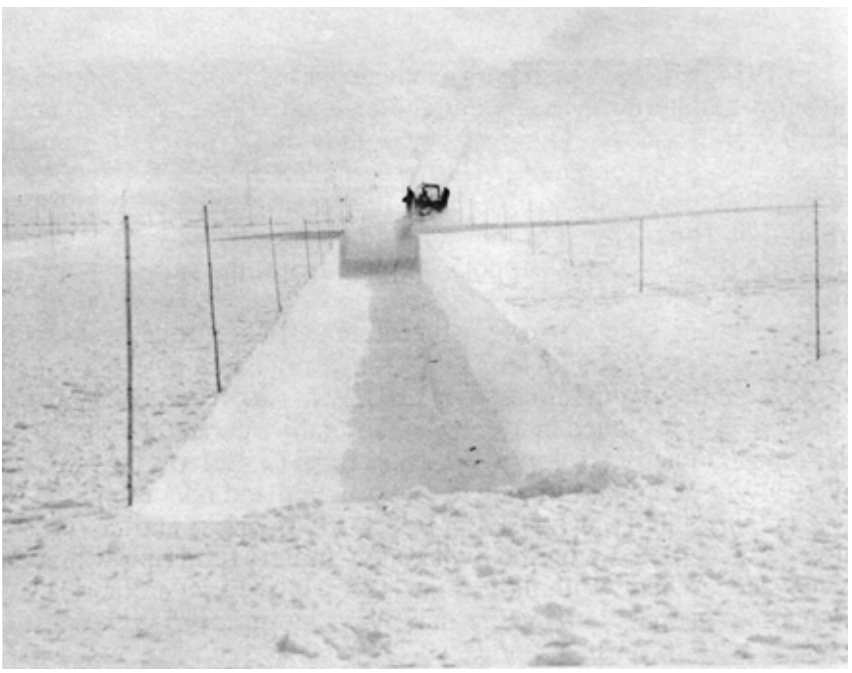
In 1955 a major problem faced the Department of Defense. At the urging of President Eisenhower, the Joint Chiefs had undertaken the complex task of planning the Distant Early Warning (DEW) Line. This network of 50 radar stations was to be built from Alaska to Greenland (during the first phase) along the northern borders of Canada's Northwest Territories. The primary problem, as was immediately apparent to the Joint Chiefs, was one of supply. It was a crash program, and it was felt that transporting the supplies by ship would cause too long a delay.

As a result, SIPRE scientists were asked if supply planes could land on sea ice. When the answer was affirmative, SIPRE was asked to conduct a test that would support these calculations. This test was carried out on the shore of Amundsen Gulf in northern Canada, with a C-124 cargo plane. Measuring devices were set on the ice to measure the deflection caused by the plane and SIPRE scientists were in constant radio contact with the pilot

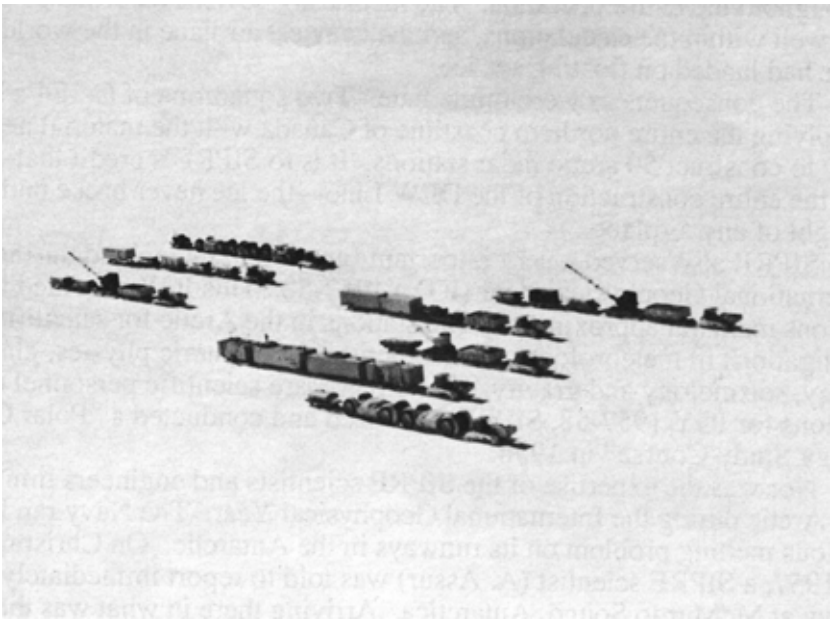
throughout the entire operation. The measuring devices recorded data that fell well within the calculations, and the heaviest airplane in the world at that time had landed on floating sea ice.

The consequences were immediate. Two squadrons of C-124's began supplying the entire northern coastline of Canada with the material necessary to construct 50 Arctic radar stations. It is to SIPRE's credit that—during the entire construction of the DEW Line—the ice never broke under the weight of any airplane. SIPRE also served a very important function in Greenland during the International Geophysical Year (IGY) 1957–58. The IGY provided that 13 nations maintain approximately 150 stations in the Arctic for scientific investigations in meteorology, geomagnetism, ionospheric physics, glaciology, seismology and gravity. To help prepare scientific personnel of all nations for IGY 1957–58, SIPRE organized and conducted a "Polar Glaciology Study Course" in 1956.

Nor was the expertise of the SIPRE scientists and engineers limited to the Arctic during the International Geophysical Year. The Navy ran into a serious melting problem on its runways in the Antarctic. On Christmas Day of 1957, a SIPRE scientist (A. Assur) was told to report immediately to the Navy at McMurdo Sound, Antarctica. Arriving there in what was their midsummer, he successfully devised methods of repairing the runway, which had been entirely unusable because of excessive melting. For doing this, Dr. Assur received the Navy's Distinguished Service Award.



Peter Plow starts to cut ramp for Project 33 at Camp Century, Greenland.

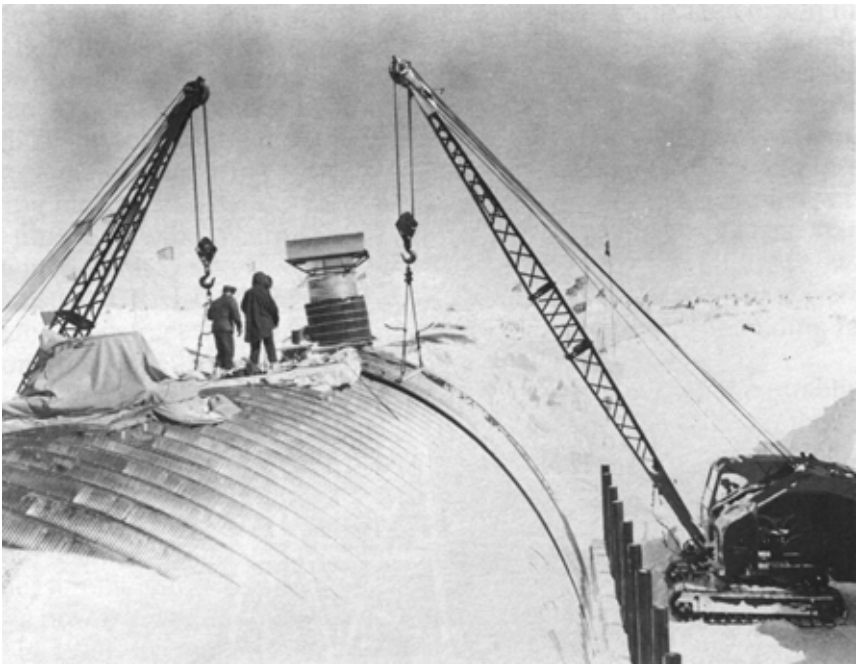


Aerial view of the heavy swing transporting supplies to Camp Century from Camp TUTO.

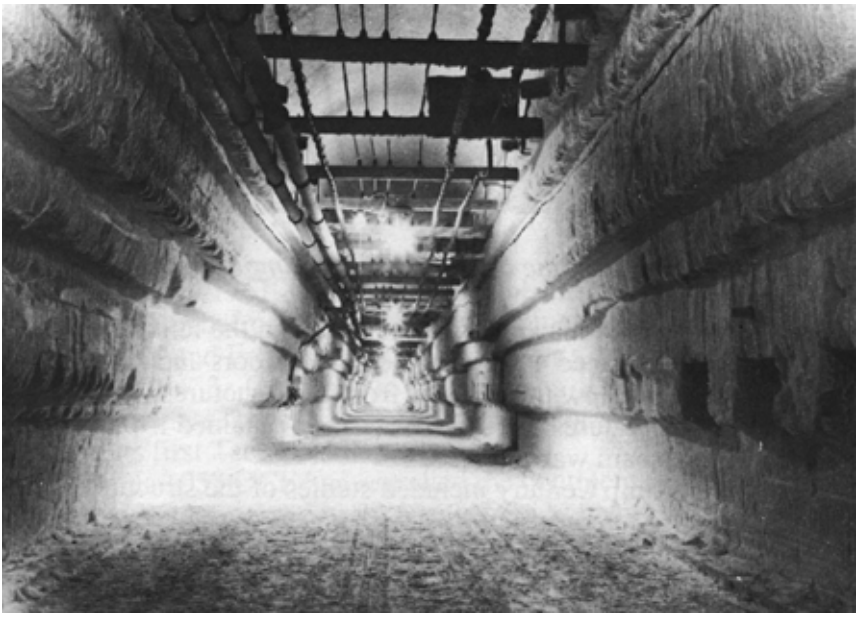
In 1954, SIPRE researchers excavated a pit 100 ft deep in the Greenland snow to determine temperature, density, hardness, strength and permeability of the snow. Two years later, they dug a 30-ft long tunnel, 7 ft wide, at the bottom of the pit. This research led directly to the construction of Camp Century, a city for 100 beneath the snow, located about 140 miles northeast of Thule. Most of the camp's construction was conceived and tested by SIPRE, and this support continued until the experiment was discontinued in 1966.

Named because it was originally located 100 trail-miles out on the ice cap, Camp Century was located in a 6200-ft-high area where winds of up to 125 miles per hour and temperatures as low as –70°F had been recorded. The camp, first occupied in 1959, was officially operated by the Army's Polar Research and Development Center from Ft. Belvoir, but SIPRE played an important part in both its construction and operation.

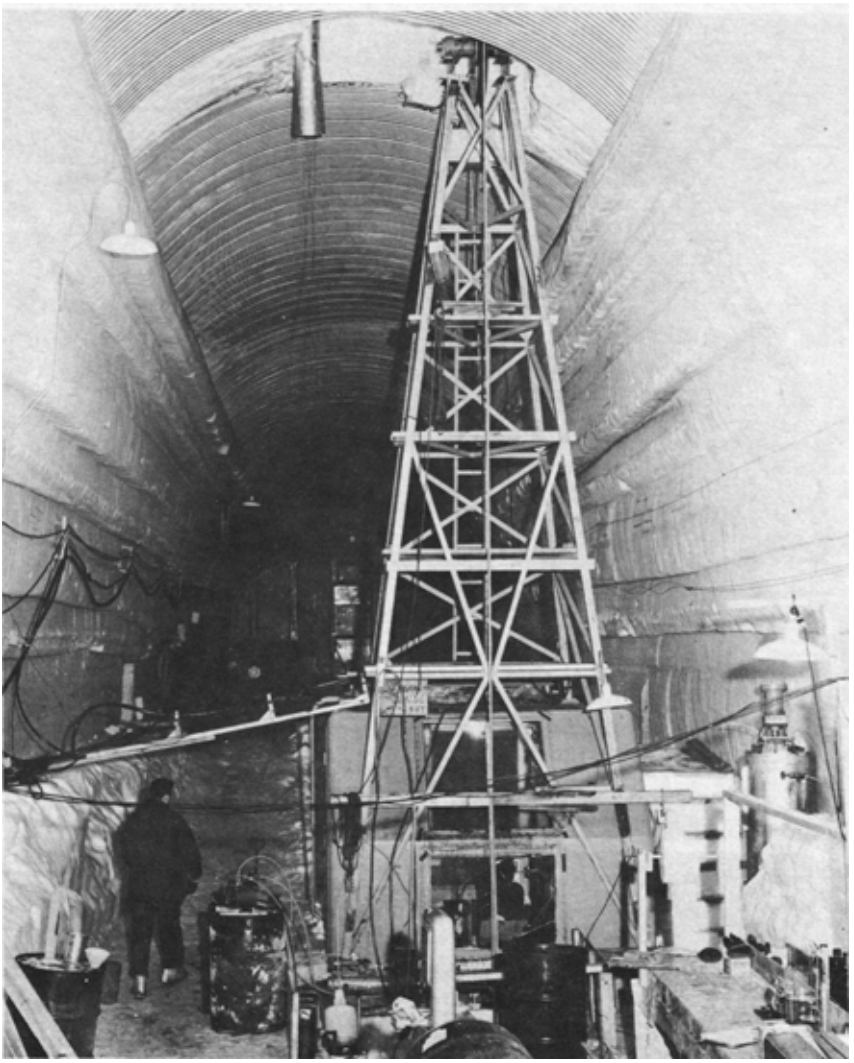
Camp Century was housed in a network of 21 cut-and-cover trenches that were constructed with the Swiss snow millers (Peter Plows) and corrugated steel arches. Within the tunnels were placed 30 prefabricated plywood buildings that contained research labs, dormitories, a mess hall, a nuclear reactor for heat and power, a dispensary, a gymnasium, a barbershop and a laundry. The largest of the tunnels, known as "Main Street," was 1100 ft long, 26 ft wide and 28 ft high. To prevent melting of the tunnel walls, a large "air well" was drilled 40 ft below the floor of each tunnel and cool air was drawn upward to maintain the tunnels at about



The raising of the arches over the Nuclear Power Trench at Camp Century.



View of main trench at Camp Century.



The thermal drill at Camp Century.

20°F. The buildings were placed 4 ft above the tunnel floors and 4 ft from the walls to prevent heat flow to the snow from the structures, which maintained indoor temperatures of 70°F. Water was obtained from a well in the snow into which steam was injected.

Research at Camp Century included studies of the structural properties of snow and its use in construction, development of transportation equipment, meteorological studies and ice core studies. It was from a tunnel in Camp Century that a CRREL drill team first reached the bottom of the Greenland Ice Sheet in 1966 at a depth of over 4550 ft.

In order to penetrate the ice sheet, the CRREL research team, drilling from one of the covered trenches at Camp Century, first made two unsuccessful attempts with a thermal drill, which melted the glacial ice. On the third hole they substituted an electromechanical drill at 1755 ft to com-

plete the project. The penetration of Greenland Ice Sheet, which had taken nearly 3 years to complete, was a significant technical accomplishment because of the difficulty of drilling through the shifting and flowing glacial ice cap, and it was a major scientific accomplishment because continuous core, representing more than 120,000 years of climatic history, was available for the first time. Since these cores contained dust particles and air pockets that had been incorporated into the glacial ice as it formed from the falling snow, scientists at CRREL and at other laboratories throughout the world were able to reconstruct the previous climate for a period of time extending far beyond the recent Ice Age.

Another important project begun during this period was the establishment of a series of ice thickness measurement stations throughout the Canadian and Alaskan Arctic. These stations, which obtained the first comprehensive ice thickness and ice formation and breakup information for northern North America, were manned by such personnel as Eskimos, school teachers, homesteaders and lodge keepers. As a result of their weekly measurements, a continuous 17- to 19-year record has been published and is now available for meteorological research.

In 1958, Colonel Walter H. Parsons, Jr., was appointed Director of SIPRE, ending the 6-year period of civilian control. Dr. Henri Bader retained his position as Chief Scientist as did James Gillis as Administrator. However, Gillis soon left SIPRE for another position in Washington, D.C., and Bader transferred to the University of Miami (Florida).

In April of 1960, Colonel William L. Nungesser assumed the command of SIPRE from Colonel Parsons, whose tour of duty had expired. Colonel Nungesser, who held a degree in industrial engineering, had previously been on the faculty of the Engineer School at Fort Belvoir, Virginia. The total professional complement of SIPRE, after 10 years, numbered 88 staff members and a board of five consultants. The time had come for SIPRE to further expand, not on its own, but through the creation of CRREL.

THE MERGER

On 1 February 1961, CRREL was established by redesignation of the Snow, Ice and Permafrost Research Establishment and merger with the Arctic Construction and Frost Effects Laboratory, as directed by U.S. Army General Order No. 3. On this date CRREL was officially created. Colonel William L. Nungesser became CRREL's first Commanding Officer and W. Keith Boyd its first Technical Director.

As early as 1953 OCE had searched the continental United States for suitable government-owned buildings that could be refurbished to satisfy the requirements of a home base for a combined SIPRE and ACFEL. They found only two: a warehouse in Seattle and the Government Center in Denver. Neither met the necessary criteria.

Again, in 1954, both SIPRE and ACFEL analyzed this matter of location—basing their analyses primarily on environmental requirements.

Their report showed that essentially five areas were suitable for relocation. These areas, having at least 100 in. of snowfall and a freezing index of at least 1500 degree days, were New England, Upstate New York, the Upper Peninsula of Michigan, the Denver area, and the region near Bozeman, Montana.

Robert Philippe, Chief of the Special Engineering Branch at OCE, favored pursuing further the possibility of a New England location. He arrived at this decision after eliminating the two other principal contenders, the Denver area and the New York state area. The Denver area was soon to become the site of the Air Force Academy and was already headquarters for the Bureau of Reclamation so that it was already surfeited with government activities. As for upper New York State, he considered it too remote from educational institutions and scientists engaged in related work.

He favored the Boston area, because it "is literally surrounded by educational institutions, Worcester Polytechnic, Holy Cross, Wellesley, Brown, Yale, Northeastern, Tufts, Harvard, MIT, Dartmouth and many others; many engaged in cold region problems... Also, there exists a severe-cold-weather station at the peak of Mount Washington, New Hampshire. The highway departments of Maine, New Hampshire, Vermont, Massachusetts and New York are actively engaged in cold-regions engineering. It will be necessary to reestablish an elementary field station, possibly at Berlin, New Hampshire, inasmuch as the immediate conditions (in the Boston area) are not satisfactory for some field tests."

Much of the interest in New Hampshire as a site for the new laboratory came from Dartmouth College at Hanover, New Hampshire. Individuals at Dartmouth had heard of the proposed merger and relocation as early as the autumn of 1954. Notable among these was Dr. John Masland, Provost of the College. As Provost, Dr. Masland was responsible for the curricula offered by Dartmouth and had wanted to introduce graduate studies leading to a master's degree or doctorate in cold regions research. Dartmouth already housed the collected papers of the arctic explorer, Vilhjalmur Stefansson, and had done some research analyses of snow and ice. Furthermore, Hanover residents felt that a cold regions laboratory—with no pollution and with a well-paid professional staff of 200 or more—would enhance their community.

On 27 December 1954, President John Sloan Dickey of Dartmouth struck up a tentative correspondence with General Sturgis:

> "It has recently come to our attention that the Corps of Engineers might be interested in Hanover, New Hampshire, and the immediate vicinity, as a permanent location for the headquarters of the Snow, Ice and Permafrost Research Establishment. We have explored the question in a very preliminary way with Mr. Robert Philippe and the outcome of this exploration seems to us to warrant further serious consideration of the matter."

General Sturgis' reply on 21 January 1955 was favorable:

> "The Corps of Engineers is very much interested in the establishment of a cold regions research laboratory near Hanover. In every way this appears to be a most suitable location, and I propose to pursue vigorously the idea of the location of such a laboratory there."

But General Sturgis was careful to add:

> "In view of the very preliminary nature of our present plans, I feel that our conversations should not become public information at this time. In due course, members of Congress primarily concerned should be informed, and this I propose to do."

Accordingly, he notified both New Hampshire senators, Styles Bridges and Norris Cotton, on 18 February 1955, two days after Philippe had visited Hanover for a talk with President Dickey. The day following this visit (17 February), the Executive Committee of the Board of Trustees of Dartmouth College voted the granting of "parcels of land not in excess of fifteen acres ... to the Government for CRREL... as the Committee on Buildings and Grounds may specifically approve."

The Chief of Engineers was denied building funds under the Military Construction Authorization (MCA) Program for the two fiscal years (1956 and 1957) following the Corps' receipt of the Hanover site. However, a preliminary design for the building was completed on 9 June 1955. Another, more comprehensive design was directed on 30 April 1956 and completed by 7 September that same year.

The 85th Congress approved this appropriation in Public Law 170 on 28 August 1957; it also authorized the establishment of a Cold Regions Engineering Laboratory under Public Law 241 on 30 August 1957. However, a review of the final plans for the laboratory revealed a deficiency that primarily concerned refrigeration; it affected the architectural design of the plan and would cost an additional $1,291,000 to rectify. This would bring the total estimated cost to $3,787,000. Consequently, OCE did not begin construction but, instead, requested the necessary additional funds from the MCA subcommittee of the House Appropriations Committee.

In April of 1959, the Committee rejected OCE's request stating it "is not convinced as to the accuracy of the cost estimates or the desirability of the location and directs that further study of available facilities be made."

The other suggested locations, having been resurrected, had to be once again thoroughly investigated. Denver and the Denver area were unsuitable for the same reasons as before. But the Naval Supply Depot at Scotia, New York, had possibilities that even Philippe had to admit. He had a complete cost analysis made on conversion of the existing facility at Scotia (a warehouse measuring 200 by 600 ft) and found that a minimal savings might be realized if the Corps chose to locate the lab there. However, these savings would soon be offset by foreseeable repair work that would have to be done on the temporary structure erected in 1946.

Finally, in 1959 Congress authorized CRREL's construction—at the previously designated location in Hanover—and granted the project the addi-

Cornerstone laying ceremonies, dinner at Thayer Hall, Dartmouth College.

tional funds it needed for fiscal year 1960. It had taken nearly 7 years to accomplish this. On 15 June 1960, the cornerstone laying ceremonies were observed.

The practical and logistical problems of moving over 200 people and their families into a small town of only about 4500 inhabitants were formidable. Consequently, on 3 February 1960, a meeting was called in Hanover to discuss these difficulties and solutions to them. Those attending represented a good cross section of the people involved in the relocation, and included individuals from OCE, SIPRE, ACFEL, Dartmouth and the Hanover Chamber of Commerce.

Although housing was the principal topic of discussion in this conference, other subjects were touched upon, including the availability of jobs in the area for the spouses of CRREL employees, taxes, school systems, food prices, the dearth of supermarkets in Hanover (at that time, there was only one) and even the local bowling alley (it had only 10 lanes).

On 11 February, immediately after his return from the meeting in Hanover, Colonel Nungesser issued a full report to everyone at SIPRE and instructed the Planning Committee to prepare a questionnaire to determine how much rental housing would be required. In the subsequent months, he made trips to address the Hanover Rotary Club, the various Chambers of Commerce in the area and other civic groups on the mission and history of SIPRE and ACFEL. He also recruited some local Hanover bankers to help dispel the notion—then widespread in Hanover—that the introduction of CRREL would dramatically escalate real estate prices.

A number of panic rumors also circulated: that the location of such a laboratory in Hanover would automatically designate the town as a prime military target; that the lab could accidentally blow up at any time, leveling the town; that the "cold regions" label was just a front for nefarious, super-secret experimentation on atomic wizardry and germ-warfare. Colonel Nungesser had a special slide show and presentation designed to dispel these rumors.

On 25 January 1961, General Order No. 3 officially established CRREL (by then the word "research" had been added to its title). In it, Colonel Nungesser was given command jurisdiction over ACFEL as well as SIPRE and the two were finally merged. One of Colonel Nungesser's first accomplishments was to reorganize the combined laboratories, appointing engineers and scientists from them both to head up the divisions and branches. Henry Manger, SIPRE's Executive Officer, had decided not to make the move to Hanover. Colonel Nungesser immediately notified OCE of the impending vacancy and Washington sent him a list of eligible names. In May of 1961, he chose Rodney F. Poland, Jr., who was Chief of Manpower Management for the Corps of Engineers and had worked with both Hallock and Philippe in their initial management development survey of SIPRE.

On 9 June 1961, General Order No. 22 required that the headquarters of CRREL be transferred to Hanover by 1 July 1961. It added: "Activities of the U.S. Army Cold Regions Research and Engineering Laboratory will be continued at both Wilmette, Illinois, and Waltham, Massachusetts, locations during the transition period until all activities can be transferred to the new headquarters."

Accordingly, Colonel Nungesser appointed a small administrative task force—much like the one that pioneered SIPRE's move from St. Paul to Wilmette 10 years earlier—and sent them on their way by 17 July. Although the task force's mailing address was Hanover, New Hampshire (P.O. Box 282), the best they could find for temporary quarters was an old warehouse across the Connecticut River in Hartford, Vermont. This warehouse, incidentally, served for both offices and lab for well over a year.

During that time, as offices and labs in the new building were completed, people would gradually move in. There was much commuting done between CRREL's unfinished laboratory and Chicago and Boston. Ice cores were stored at the Fulton Mart in Chicago and the coldrooms in Waltham. Until coldroom facilities were completed in the new lab, commuting to and from these locations was routine—and tiresome. But morale was high, because the people of CRREL knew they were finally achieving the recognition they deserved in a laboratory especially suited to cold regions research.

By 1 January 1962, the second floor offices of the new building had been completely occupied and the basement had been completed. The basement housed only refrigeration equipment and a machine shop. Luckily, as it turned out four days later, the New England Division had refused CRREL permission to use the basement as a storage area until the entire building

had become operational. The designers had designated the first to be used primarily as a laboratory area, with 24 coldrooms at the core. The contractors had scheduled the completion of this section for last. It very nearly was last: the last of the entire building.

On Thursday, 4 January, at 6:30 a.m., a worker engaged in constructing CRREL's coldrooms reported to work as usual. His first job, each morning, was to light fires under several kettles of tar that had been placed at various locations around the area in which the coldrooms were being built. The coldrooms were being built of 1-ft-thick foamed glass blocks and adhesive used for both blocks and the overlying insulation was tar. The contractors had been heating the tar outside in a large vat and transferring it, as needed, to smaller kettles within the building. However, it was necessary to rig small gas burners under the kettles in order to keep the tar hot. These were fed propane gas through a rubber hose from several tanks in the area.

After lighting the first burner, this employee left to light the others. But when he returned, he found the entire wall behind the pot was ablaze. He tried to extinguish it with a fire extinguisher but a propane tank exploded, spewing flames around the entire room. He then sounded the alarm. Luckily, he escaped with only minor burns. The fire soon spread to envelop other partially completed coldrooms and tar pots. The heat generated by these, combined with the fire from the propane gas, melted foamed glass walls, pipes and even some structural beams.

Smoke at CRREL's front entrance during construction fire, 4 January 1962.

The Fire Departments of Hanover, Etna and Lebanon all responded to the blaze. Although the fire was never out of control, it was extremely difficult to fight because of the heat and the tremendous volume of acrid, black smoke it caused. The firemen had to wear breathing masks. They soon required additional oxygen, which was flown from Pease Air Force Base in Portsmouth, New Hampshire.

The fire was contained about 10:00 a.m. that morning, but the entire building had been severely damaged by the smoke. Water on the first floor was about 2 in. deep. Estimates of the damage were close to $350,000, but the cost caused by delay was incalculable. No sooner had the staff finally settled into what they supposed to be their permanent quarters than they were uprooted. The search for improvised labs and temporary office space was renewed and, again, Dartmouth College and the local communities gave their complete cooperation to the people of CRREL. It was necessary to replace most of the electrical facilities and wiring in the new building. And scrubbing the building down to rid it of the soot and grime left by the smoke took many months. According to some, it could still be sensed after a full year had passed. Indeed, the fire had so disrupted the completion of the laboratory that the dedication ceremonies were postponed until 21–23 November 1963.

CONSOLIDATION AND PROGRESS

In 1962, the Army was reorganized to reduce the duplication of effort among the services. Accordingly, the various Corps' responsibilities were portioned out to Commands that were created specifically to administer to these responsibilities. The training function, for instance, was given to the Continental Army Command, headquartered at Fort Monroe. And research and development were allotted to the U.S. Army Materiel Command (USAMC). According to AMC General Order No. 5, dated 26 July 1962: 275 Corps of Engineers "installations and activities" located in the U.S., Canada and England were assigned to the AMC. One of these was the still not completely operational facility called the Cold Regions Research and Engineering Laboratory.

Some of the CRREL staff welcomed the lab's transfer to the Army Materiel Command because they thought that this change could broaden their mission and the scope of their research activities. Unfortunately, the only immediate change was in the foyer of the new building. The Corps of Engineers had emblazoned its emblem—the castle—on the floor of the lobby. This emblem was soon covered with a rug.

Actually, very little else was changed. Colonel Nungesser was still the Commander, but served under the AMC. CRREL reported directly to AMC as it had previously to OCE. However, OCE continued to work directly with CRREL on many projects because they had a financial stake in the projects' outcome.